Data Sheet | May 10, 2007 | FN6226.0

Dual Channel Central Office ADSL2+ Line Driver

The ISL1535 is a very low power dual channel differentiated amplifier designed for central office line driving for DMT ADSL2+ solutions. This device features a high drive capability of 600mA while consuming 5.2mA of supply current per amplifier from ±12V supplies. This driver achieves a typical distortion of less than -75dBc, at 1MHz into a 50Ω load. The ISL1535 is available in 28 Ld HTSSOP package. This device is specified for operation over the full -40°C to +85°C temperature range.

The ISL1535 has two control pins, C_0 and C_1, per channel. With the selection of C_0 and C_1, the device can be set into full-I_S power, 3/4-I_S power, 1/2-I_S power, and power-down disable modes. The ISL1535 maintains excellent distortion and load driving capabilities even in the lowest power settings. The ISL1535 has extended bandwidth, low THD and high slew rate for ADSL2+ applications.

Ordering Information

PART NUMBER (Note)	PART MARKING	TAPE & REEL	PACKAGE (Pb-free)	PKG. DWG. #
ISL1535IVEZ	ISL1535 IVEZ	-	28 Ld HTSSOP	MDP0048
ISL1535IVEZ-T13	ISL1535 IVEZ	13”	28 Ld HTSSOP	MDP0048
ISL1535IRZ	1535 IRZ	-	24 Ld QFN	MDP0046
ISL1535IRZ-T13	1535 IRZ	13”	24 Ld QFN	MDP0046

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free ruirements of IPC/JEDEC J STD-020.

Features

- Drives 400mA at 16V_{P-P} on ±12V supplies
- 21.4V_{P-P} differential output drive into 100Ω
- 20.6V_{P-P} minimum differential output drive into 60Ω
- -75dBc typical driver output distortion driving 50Ω at 1MHz and 1/2-I_S bias current
- Quiescent current of 5.2mA per amplifier in 1/2-I_S mode
- 100MHz BW at A_V = 10
- Current control pins to select power modes
- Pin-to-pin replacement for EL1527 and EL1537
- Pb-free plus anneal available (RoHS compliant)

Applications

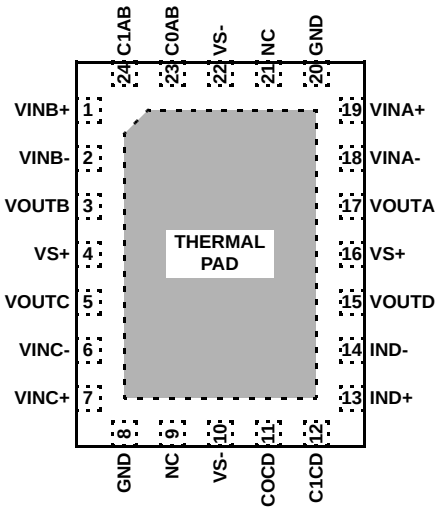
- ADSL, ADSL2, ADSL2+ line drivers
- G.SHDSL, HDSL2 line drivers
- VDSL line drivers
- Video distribution amplifiers
- Video twisted-pair line drivers

CONFIDENTIAL

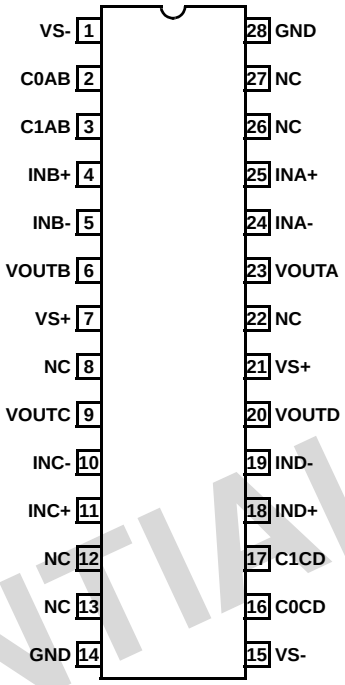
CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
1-888-INTERSIL or1-888-468-3774 | Intersil (and design) is a registered trademark of Intersil Americas Inc.
Copyright © Intersil Americas Inc. 2007. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Pinouts

ISL1535IRZ
(24 LD QFN)
TOP VIEW



ISL1535IVEZ
(28 LD HTSSOP)
TOP VIEW



CONFIDENTIAL

Pin Descriptions

28 LD HTSSOP	24 LD QFN	PIN NAME	FUNCTION
1, 15	10, 22	VS-	Negative supply
2	23	C0AB (Note 1)	DSL Channel 1 current control pin
3	24	C1AB (Note 1)	DSL Channel 1 current control pin
4	1	VINB+	Amplifier B non-inverting input
5	2	VINB-	Amplifier B inverting input
6	3	VOUTB	Amplifier B output
7, 21	4, 16	VS+	Positive supply
8, 12, 13, 22, 26, 27	9, 21	NC	Not connected
9	5	VOUTC	Amplifier C output
10	6	VINC-	Amplifier C inverting input
11	7	VINC+	Amplifier C non-inverting input
14, 28	8, 20	GND	Ground connection
16	11	C0CD (Note 2)	DSL Channel 2 current control pin
17	12	C1CD (Note 2)	DSL Channel 2 current control pin
18	13	VIND+	Amplifier D non-inverting input
19	14	VIND-	Amplifier D inverting input
20	15	VOUTD	Amplifier D output
23	17	VOUTA	Amplifier A output
24	18	VINA-	Amplifier A inverting input
25	19	VINA+	Amplifier A non-inverting input

NOTES:

1. Amplifiers A and B comprise DSL Channel 1. C_{0AB} and C_{1AB} control I_S settings for DSL Channel 1.
2. Amplifiers C and D comprise DSL Channel 2. C_{0CD} and C_{1CD} control I_S settings for DSL Channel 2.

CONFIDENTIAL

Absolute Maximum Ratings (T_A = +25°C)

V_S+ to V_S- Supply Voltage. 33V
V_S+ Voltage to Ground . . . . . .-0.3V to +33V
V_S- Voltage to Ground . . . . . .-33V to 0.3V
Input C_0/C_1 to Ground 7V
V_{IN}+ Voltage . . . . . V_S- to V_S+
Current into any Input 8mA
ESD Rating
Human Body Model (Per MIL-STD-883 Method 3015.7) 3kV
Machine Model (Per EIAJ ED-4701 Method C-111). 100V

Thermal Information

Continuous Output Current 75mA
Ambient Operating Temperature Range . . . . . .-40°C to +85°C
Storage Temperature Range . . . . . .-60°C to +150°C
Operating Junction Temperature . . . . . .+150°C
Power Dissipation . . . .See Power Supplies and Dissipation section
Pb-free reflow profile . . . . . .see link below
http://www.intersil.com/pbfree/Pb-FreeReflow.asp

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typ values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

Electrical Specifications

V_S = ±12V, R_F = 1.5kΩ, R_L = 50Ω to GND, T_A = +25°C, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
AC PERFORMANCE						
BW	-3dB Bandwidth	A_V = 10		100		MHz
HD	Total Harmonic Distortion	f = 1MHz, $V_O = 16V_{P-P}$, R_L = 50Ω		-75		dBc
HD3	3rd Harmonic Distortion	f = 2.2MHz, $V_O = 5.5V_{P-P}$, R_L = 50Ω		-58	-55	dBc
dG	Differential Gain	A_V = +2, R_L = 37.5Ω		0.11		%
dθ	Differential Phase	A_V = +2, R_L = 37.5Ω		0.1		°
SR	Slew Rate, Single-Ended Signal	V_{OUT} from -4.5V to +4.5V	270	500		V/µs
DC PERFORMANCE						
V_{OS}	Offset Voltage		-10		+10	mV
ΔV_{OS}	V_{OS} Mismatch		-2.5		+2.5	mV
R_{OL}	Transimpedance	V_{OUT} from -9V to +9V	1	4	10	MΩ
INPUT CHARACTERISTICS						
I_B+	Non-Inverting Input Bias Current		-25		+25	µA
I_B-	Inverting Input Bias Current		-100		70	µA
ΔI_B-	I_B- Mismatch		-20		20	µA
e_N	Input Noise Voltage			3.9		nV√Hz
i_N+	+Input Noise Current			4.7		pA/√Hz
i_N-	-Input Noise Current			10		pA/√Hz
V_{IH}	Input High Voltage	C_0 and C_1 inputs	2.0			V
V_{IL}	Input Low Voltage	C_0 and C_1 inputs			0.8	V
I_{IH}	Input High Current for C_1or C_0	C_1 = 5V, C_0 = 5V	50	100	200	µA
I_{IL}	Input Low Current for C_1or C_0	C_1 = 0V, C_0 = 0V	-1		1	µA
OUTPUT CHARACTERISTICS						
V_{OUT}	Loaded Output Swing Single-Ended	R_L = 100Ω to GND	±10.5	±10.8		V
V_{OUT} P	Loaded Output Swing Single-Ended	R_L = 30Ω to GND	10	10.4		V
V_{OUT} N	Loaded Output Swing Single-Ended	R_L = 30Ω to GND		-10.4	-10	V
I_{OUT}	Output Current	R_L = 0Ω		500		mA

CONFIDENTIAL

Electrical Specifications V_S = ±12V, R_F = 1.5kΩ, R_L = 50Ω to GND, T_A = +25°C, unless otherwise specified. **(Continued)**

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY						
V_S	Supply Voltage	Single supply	5		30	V
I_{S^+} (Full Power)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 0V		13.3		mA
I_{S^-} (Full Power)	Negative Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 0V		-13.0		mA
I_{S^+} (3/4 Power)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = 5V, C_1 = 0V		10.5		mA
I_{S^-} (3/4 Power)	Negative Supply Current per Amplifier	All outputs at 0V, C_0 = 5V, C_1 = 0V		-10.2		mA
I_{S^+} (1/2 Power)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = 0V, C_1 = 5V		5.25	6.2	mA
I_{S^-} (1/2 Power)	Negative Supply Current per Amplifier	All outputs at 0V, C_0 = 0V, C_1 = 5V	-6.0	-5.0		mA
I_{S^+} (Power Down)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 5V		0.5	0.75	mA
I_{S^-} (Power Down)	Negative Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 5V	-0.5	-0.2		mA
I_{GND}	GND Supply Current per Amplifier	All outputs at 0V		0.25		mA

Typical Performance Curves

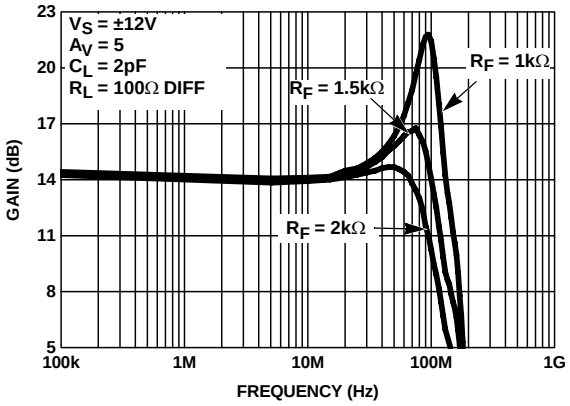


FIGURE 1. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (FULL POWER MODE)

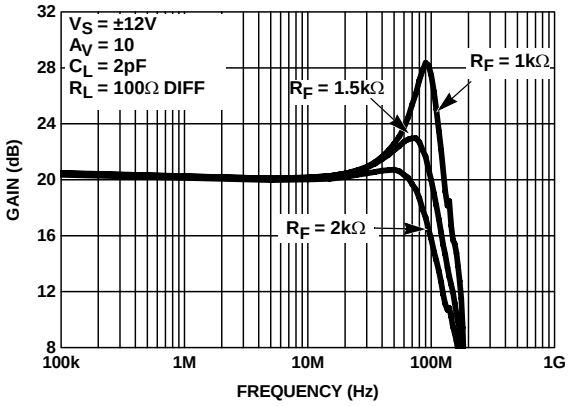


FIGURE 2. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (FULL POWER MODE)

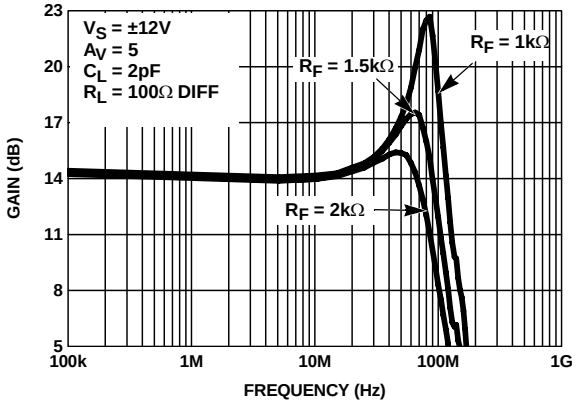


FIGURE 3. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (3/4-POWER MODE)

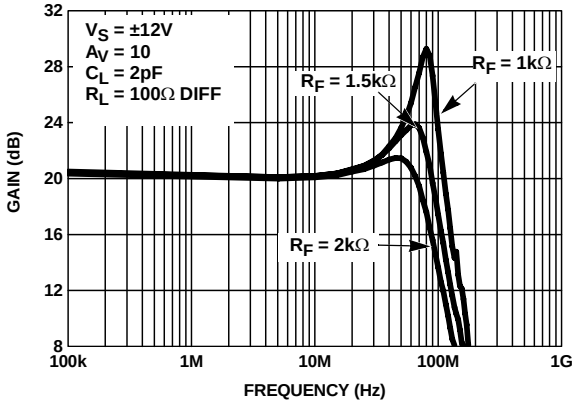


FIGURE 4. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (3/4-POWER MODE)

Typical Performance Curves (Continued)

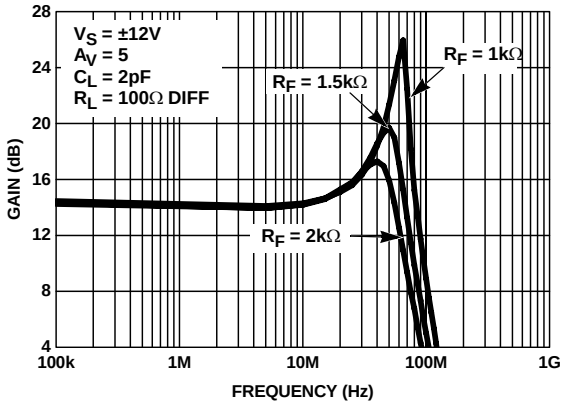


FIGURE 5. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (1/2-POWER MODE)

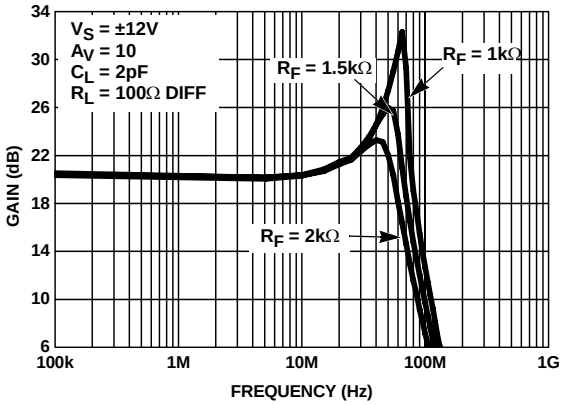


FIGURE 6. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (1/2-POWER MODE)

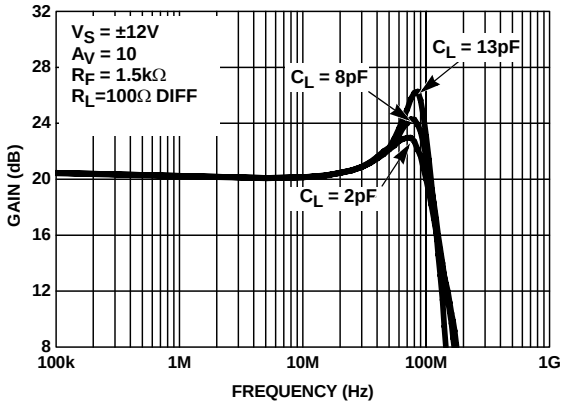


FIGURE 7. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS C_{LOAD} (FULL POWER MODE)

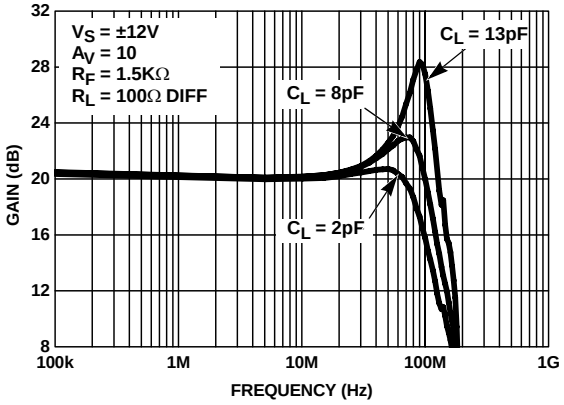


FIGURE 8. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS C_{LOAD} (3/4-POWER MODE)

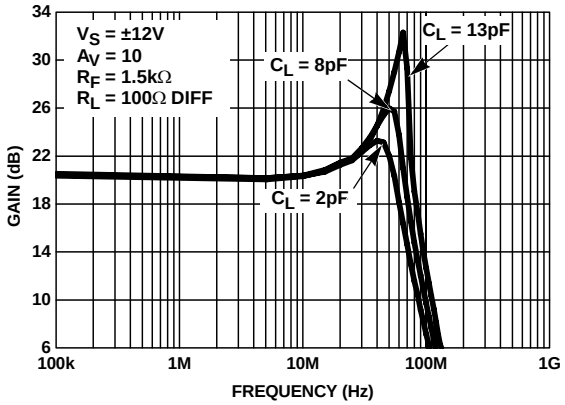


FIGURE 9. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS C_{LOAD} (1/2-POWER MODE)

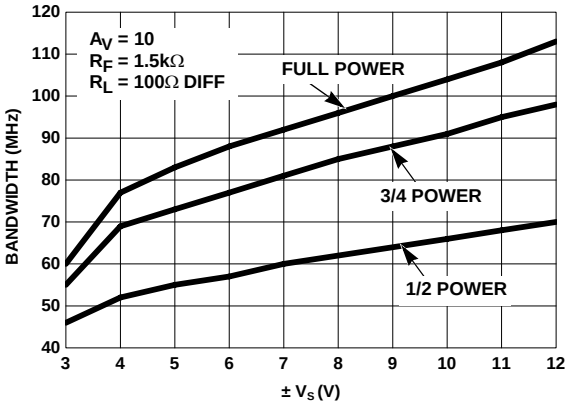


FIGURE 10. DIFFERENTIAL BANDWIDTH vs SUPPLY VOLTAGE

Typical Performance Curves (Continued)

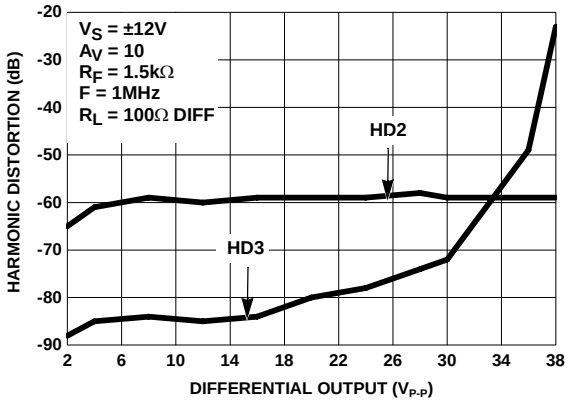


FIGURE 11. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (FULL POWER MODE)

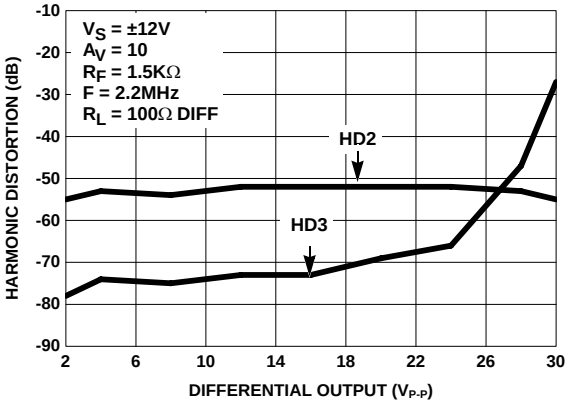


FIGURE 12. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (FULL POWER MODE)

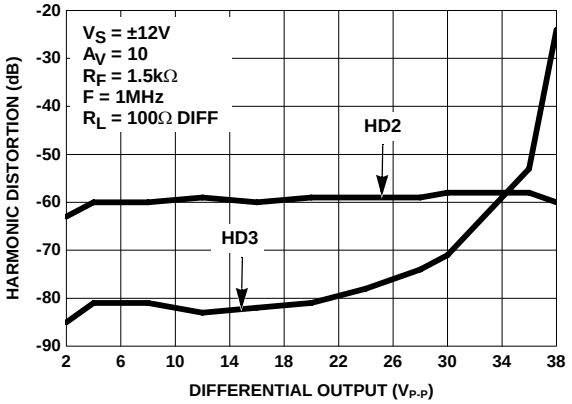


FIGURE 13. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (3/4-POWER MODE)

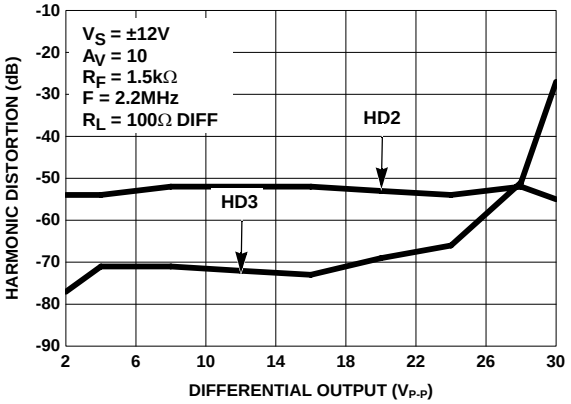


FIGURE 14. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (3/4-POWER MODE)

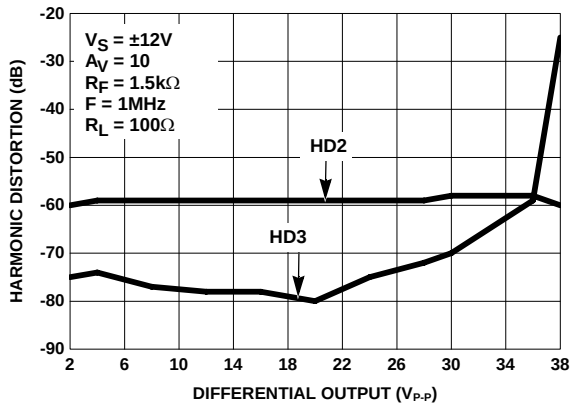


FIGURE 15. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (1/2-POWER MODE)

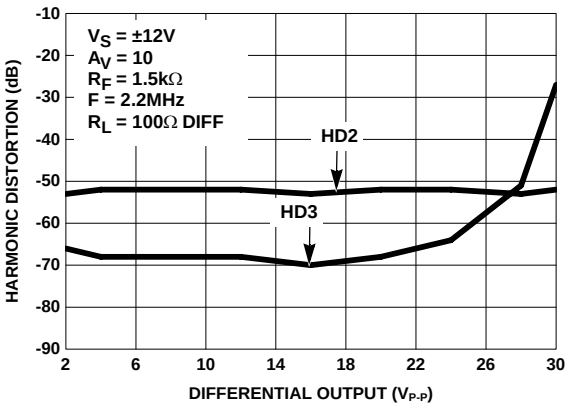


FIGURE 16. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT AMPLITUDE (1/2-POWER MODE)

Typical Performance Curves (Continued)

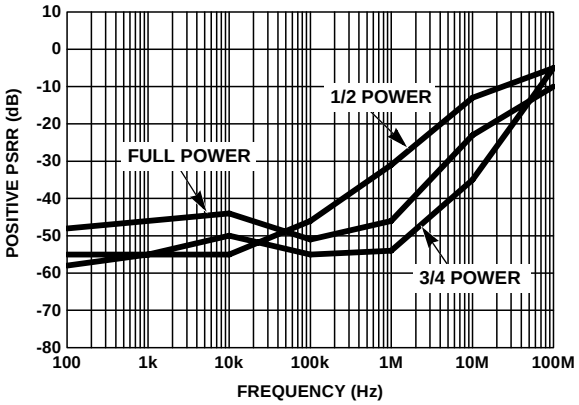


FIGURE 17. POSITIVE PSRR vs FREQUENCY

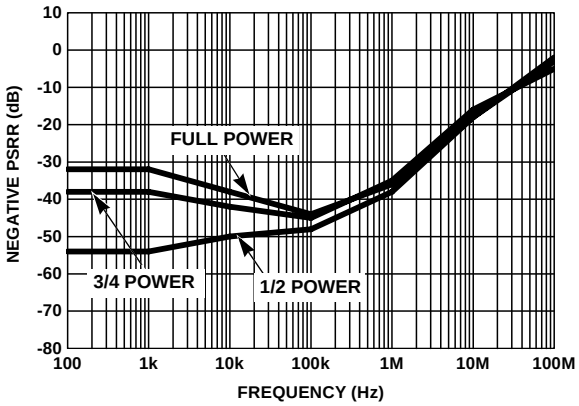


FIGURE 18. NEGATIVE PSRR vs FREQUENCY

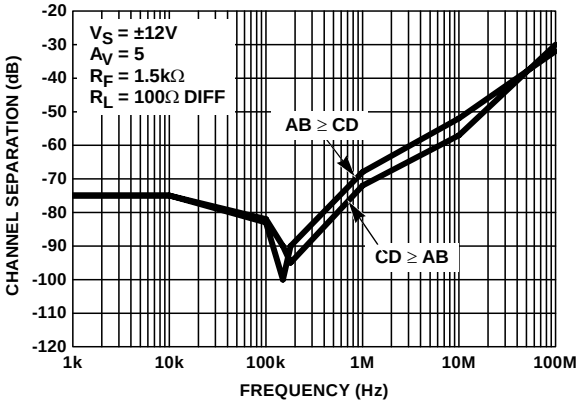


FIGURE 19. CHANNEL SEPARATION vs FREQUENCY

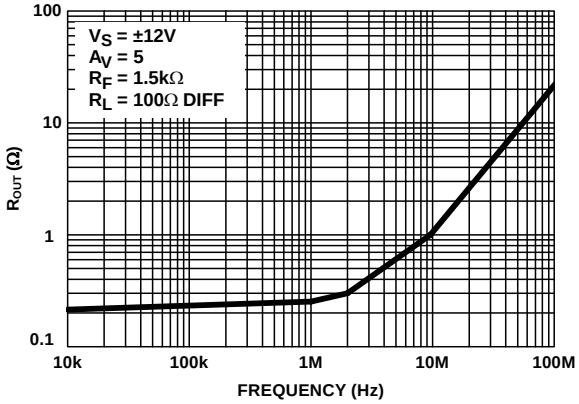


FIGURE 20. OUTPUT IMPEDANCE vs FREQUENCY (ALL POWER LEVELS)

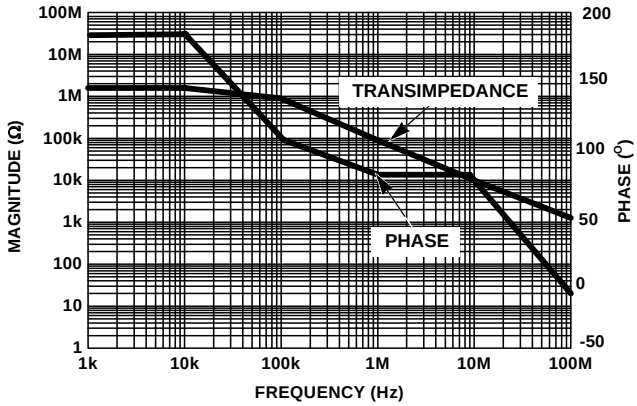


FIGURE 21. TRANSIMPEDANCE (ROL) vs FREQUENCY

Typical Performance Curves (Continued)

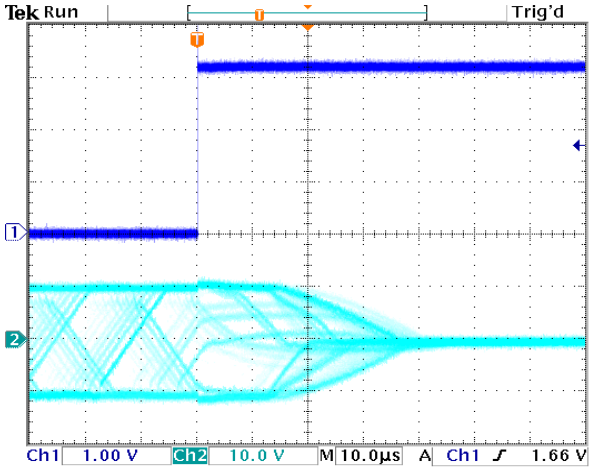


FIGURE 22. DISABLE RESPONSE

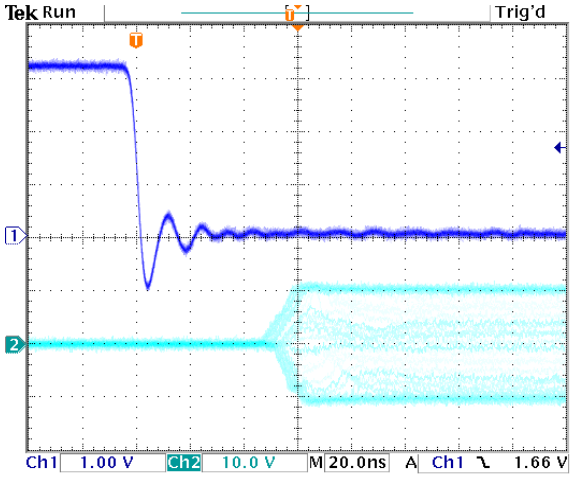


FIGURE 23. ENABLE RESPONSE

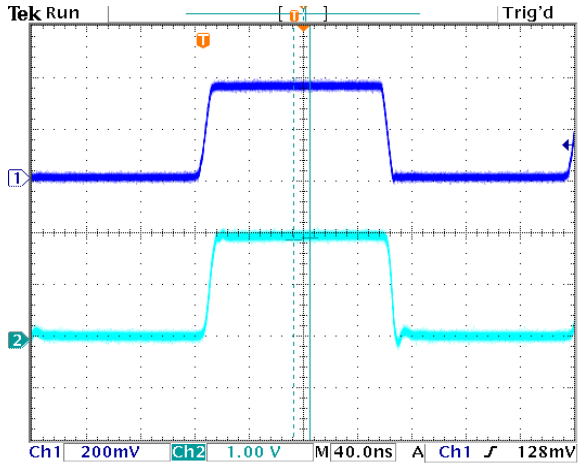


FIGURE 24. SMALL STEP RESPONSE

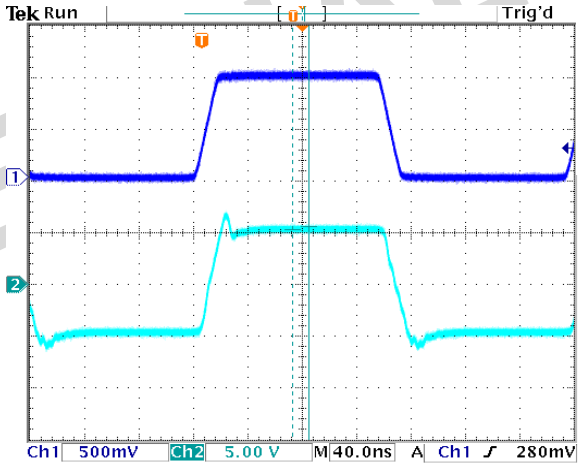


FIGURE 25. LARGE STEP RESPONSE

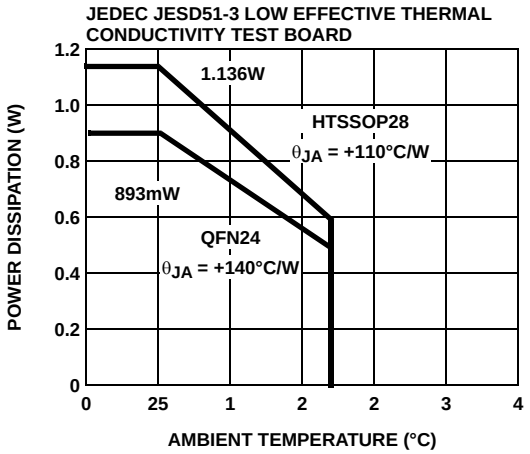


FIGURE 26. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

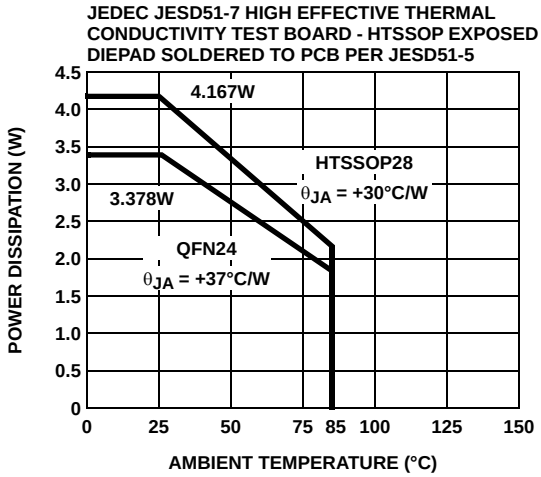


FIGURE 27. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

Applications Information

The ISL1535 consists of two sets of high-power line driver amplifiers that can be connected for full duplex differential line transmission. The amplifiers are designed to be used with signals up to 4MHz and produce low distortion levels. A typical interface circuit is shown in Figure 28.

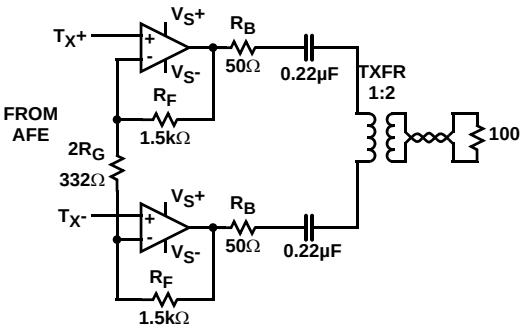


FIGURE 28. TYPICAL LINE INTERFACE CONNECTION

The driver takes a differential signal and generate a differential output. Each amplifier has identical positive gain connections for optimum common-mode rejection to occur. Further, DC input errors are duplicated, creating common-mode rather than differential line errors.

Feedback Resistor Value

The bandwidth and peaking of the amplifiers varies with feedback and gain settings. The feedback resistor values can be adjusted to produce an optimal frequency response.

Table 1 lists the recommended resistor values which produce an optimal driver frequency response.

TABLE 1. OPTIMUM DRIVER FEEDBACK RESISTOR FOR VARIOUS GAINS

SUPPLY VOLTAGE	DRIVER VOLTAGE GAIN	
	5	10
±12V @ Full Power	1.5k	1.5k
±12V @ 1/2 Power	3k	2k

Power Control Function

The ISL1535 contains two forms of power control operation. Two digital inputs (C_0 and C_1) can be used to control the supply current of the ISL1535 drive amplifiers. As the supply current is reduced, the ISL1535 will start to exhibit slightly higher levels of distortion and the frequency response will be limited. The four power modes of the ISL1535 are set up as shown in Table 2.

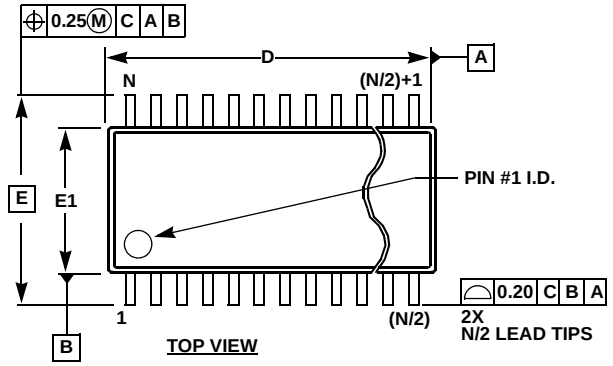
TABLE 2. POWER MODES OF THE ISL1535

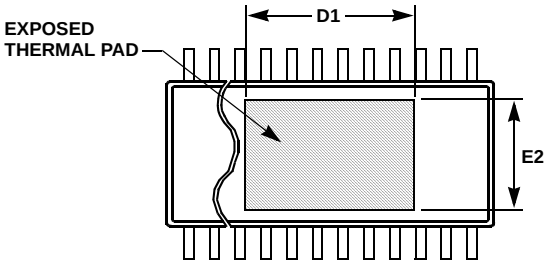
C_1	C_0	OPERATION
0	0	I_S Full Power Mode
0	1	3/4-I_S Power Mode
1	0	1/2-I_S Power Mode
1	1	Power Down

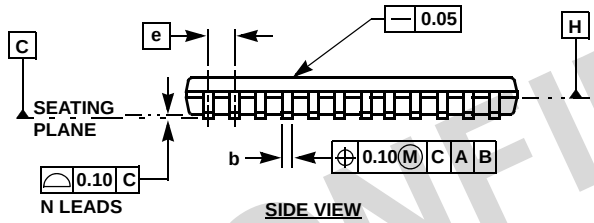
See ISL1535 Application Notes for further information.

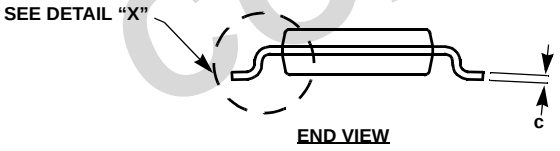
CONFIDENTIAL

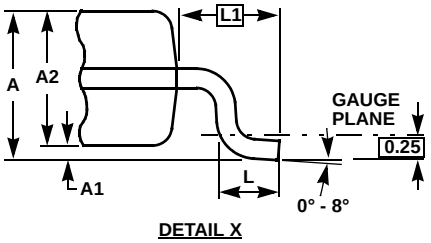
HTSSOP (Heat-Sink TSSOP) Family











MDP0048

HTSSOP (HEAT-SINK TSSOP) FAMILY

SYMBOL	MILLIMETERS					TOLERANCE
	14 LD	20 LD	24 LD	28 LD	38 LD	
A	1.20	1.20	1.20	1.20	1.20	Max
A1	0.075	0.075	0.075	0.075	0.075	±0.075
A2	0.90	0.90	0.90	0.90	0.90	+0.15/-0.10
b	0.25	0.25	0.25	0.25	0.22	+0.05/-0.06
c	0.15	0.15	0.15	0.15	0.15	+0.05/-0.06
D	5.00	6.50	7.80	9.70	9.70	±0.10
D1	3.2	4.2	4.3	5.0	7.25	Reference
E	6.40	6.40	6.40	6.40	6.40	Basic
E1	4.40	4.40	4.40	4.40	4.40	±0.10
E2	3.0	3.0	3.0	3.0	3.0	Reference
e	0.65	0.65	0.65	0.65	0.50	Basic
L	0.60	0.60	0.60	0.60	0.60	±0.15
L1	1.00	1.00	1.00	1.00	1.00	Reference
N	14	20	24	28	38	Reference

Rev. 3 2/07

NOTES:

1. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15mm per side.
2. Dimension “E1” does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm per side.
3. Dimensions “D” and “E1” are measured at Datum Plane H.
4. Dimensioning and tolerancing per ASME Y14.5M-1994.

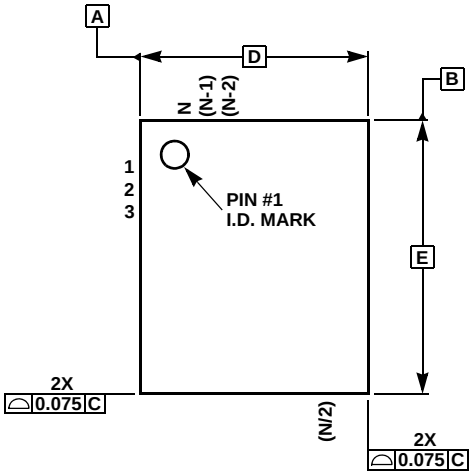
CONFIDENTIAL

All Intersil U.S. products are manufactured, assembled and tested utilizing ISO9000 quality systems.
Intersil Corporation’s quality certifications can be viewed at www.intersil.com/design/quality

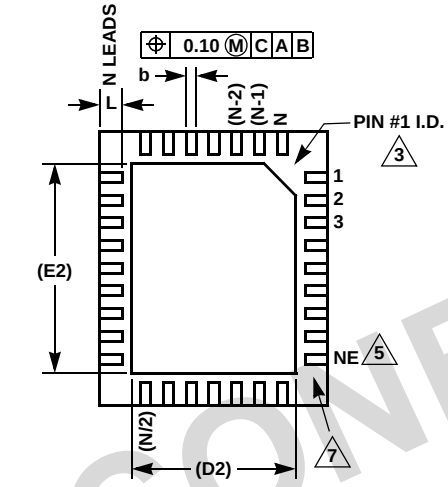
Intersil products are sold by description only. Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that data sheets are current before placing orders. Information furnished by Intersil is believed to be accurate and reliable. However, no responsibility is assumed by Intersil or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Intersil or its subsidiaries.

For information regarding Intersil Corporation and its products, see www.intersil.com

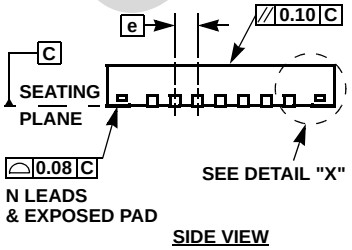
QFN (Quad Flat No-Lead) Package Family



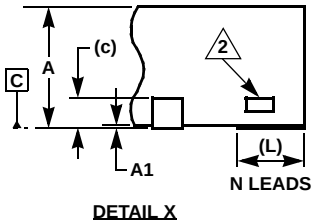
TOP VIEW



BOTTOM VIEW



SIDE VIEW



DETAIL X

MDP0046

QFN (QUAD FLAT NO-LEAD) PACKAGE FAMILY (COMPLIANT TO JEDEC MO-220)

SYMBOL	MILLIMETERS				TOLERANCE	NOTES
	QFN44	QFN3	QFN32			
A	0.90	0.90	0.90	0.90	±0.10	-
A1	0.02	0.02	0.02	0.02	+0.03/-0.02	-
b	0.25	0.25	0.23	0.22	±0.02	-
c	0.20	0.20	0.20	0.20	Reference	-
D	7.00	5.00	8.00	5.00	Basic	-
D2	5.10	3.80	5.80	3.60/2.48	Reference	8
E	7.00	7.00	8.00	6.00	Basic	-
E2	5.10	5.80	5.80	4.60/3.40	Reference	8
e	0.50	0.50	0.80	0.50	Basic	-
L	0.55	0.40	0.53	0.50	±0.05	-
N	44	38	32	32	Reference	4
ND	11	7	8	7	Reference	6
NE	11	12	8	9	Reference	5

SYMBOL	MILLIMETERS					TOLER-ANCE	NOTES
	QFN28	QFN2	QFN20		QFN16		
A	0.90	0.90	0.90	0.90	0.90	±0.10	-
A1	0.02	0.02	0.02	0.02	0.02	+0.03/ -0.02	-
b	0.25	0.25	0.30	0.25	0.33	±0.02	-
c	0.20	0.20	0.20	0.20	0.20	Reference	-
D	4.00	4.00	5.00	4.00	4.00	Basic	-
D2	2.65	2.80	3.70	2.70	2.40	Reference	-
E	5.00	5.00	5.00	4.00	4.00	Basic	-
E2	3.65	3.80	3.70	2.70	2.40	Reference	-
e	0.50	0.50	0.65	0.50	0.65	Basic	-
L	0.40	0.40	0.40	0.40	0.60	±0.05	-
N	28	24	20	20	16	Reference	4
ND	6	5	5	5	4	Reference	6
NE	8	7	5	5	4	Reference	5

Rev 11 2/07

NOTES:

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Tiebar view shown is a non-functional feature.
3. Bottom-side pin #1 I.D. is a diepad chamfer as shown.
4. N is the total number of terminals on the device.
5. NE is the number of terminals on the “E” side of the package (or Y-direction).
6. ND is the number of terminals on the “D” side of the package (or X-direction). ND = (N/2)-NE.
7. Inward end of terminal may be square or circular in shape with radius (b/2) as shown.
8. If two values are listed, multiple exposed pad options are available. Refer to device-specific datasheet.

CONFIDENTIAL